

pathology, for all forms of criminal and civil legal practice. Home Office regional forensic science laboratories serve only the police and prosecution service and exclude pathology. Apparently the working party visited the Copenhagen Institute, but it is not mentioned in the report, and the medicolegal institutes in Germany, which enjoy a worldwide reputation, are ignored.

Any suggestion that forensic pathology might be "subsumed" within the forensic science service is rejected outright by the working party, which sees the role of the Home Office as "strictly limited to ensuring that the 'market' for forensic pathology services is such that supply and demand are equated without any sacrifice of quality." Accordingly, the report goes no further than suggesting that "within the Home Office, responsibility for the forensic pathology service should be related to that for forensic science." There is a passing reference to the Trenchard committee's proposal in 1936 that there should be a single forensic medicine institute in London, but the working party thought that the concentration of all London forensic pathology work in one place would have a serious effect on the four London departments and their medical schools.

The report assumes throughout that any radical reorganisation would damage a forensic pathology service that is "recognised to be among the best in the world," and that there

would be serious consequences for both undergraduate and postgraduate training in forensic medicine and pathology. Although the working party referred to the finding of a European Community working party that standards of proficiency in forensic medicine in Britain fall far below those expected of a doctor free to practice medicine in other European countries, it nevertheless refused to consider the organisation of forensic pathology services in those countries and the effect that they have on relevant medical training.

Forensic pathologists may be expected to welcome this report because it preserves their exceptional degree of independence. The police will be relieved that it managed to avoid any reference to their exclusive access to the regional forensic science laboratories—an unfair advantage that sits uneasily under an adversarial system of justice. The government will be the most relieved because its acceptance of the report conveniently postpones the inevitable and radical reorganisation of the service, which is so long overdue. The verdict of posterity, however, will be a different matter.

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1 Knight B. Forensic pathology: the chronic crisis. *BMJ* 1985;291:1145.

2 Brodrick N. *Report of the committee on death certification and coroners*. London: HMSO, 1971.

3 Home Office. *Report of the working party on forensic pathology*. London: HMSO, 1989.

Regular Review

Ultrasonography in the diagnosis of renal obstruction

Sensitive but not very specific

Intravenous urography has been a mainstay of the diagnosis of renal obstruction for many years. One of the principal signs it shows is dilatation of the pelvicaliceal system and ureter proximal to the site of obstruction. Not all dilated collecting systems, however, are obstructed, and various urographic criteria are used to identify non-obstructive dilatation.¹

Urography requires using ionising radiation and contrast medium, both of which carry small risks to the patient. About 5% of patients develop minor side effects,^{2,3} less than 0.1% develop major complications, and the mortality with ionic contrast media is between 1 in 40 000 and 1 in 75 000.^{2,4}

Recognition that the cheaper and less invasive technique of ultrasonography can detect dilatation of the collecting system has led to its widespread use in place of urography to diagnose obstruction.⁵ Recently, however, doubts have been voiced about the reliability of the procedure after reports of patients with obstruction in whom no dilatation was shown by ultrasonography.⁶⁻¹⁰ One commentator claimed that "ultrasound is not good at detecting dilatation of the pelvicaliceal system and is subject to false positive and false negative errors."¹¹ This review will reconsider the value and place of ultrasonography in diagnosing renal obstruction with particular attention to its sensitivity and its ability to separate obstructive from non-obstructive causes of dilatation.

Urographic diagnosis of obstruction

Intravenous urography identifies urinary tract dilatation caused by obstruction. The excellent detailed images it provides of the pelvicaliceal system allow detection of mild

caliceal blunting—the earliest sign of dilatation of the collecting system. Provided that the obstructed kidney excretes sufficient contrast medium, urography will show the anatomy of the pelvicaliceal system and ureter down to the site of obstruction. At the obstruction there will be a partial or complete hold up of the passage of contrast medium, which, together with delayed pelvicaliceal filling, indicates that the dilatation is obstructive. In acute obstruction, often caused by ureteric calculus, further evidence of obstruction will be given by a nephrogram, which increases in density with time.

Carefully conducted urography will also identify most non-obstructive causes of pelvicaliceal dilatation. The most common are distensible systems, usually after obstruction or after infection during pregnancy¹²; vesicoureteric reflux; and congenital variants and anomalies—for example, extrarenal pelvis, megacalix, and megaureter.

Distensible systems appear dilated in the early urogram films but drain on the later ones.¹² Vesicoureteric reflux should be suspected if there is variable dilatation of the pelvicaliceal system and ureter during urography or if dilatation predominantly affects the lower ureter. In non-obstructed extrarenal pelvis the contrast medium washes out after intravenous frusemide, whereas in pelviureteric junction obstruction the pelvis distends further and the patient usually experiences pain. Most congenital anomalies causing dilatation show typical features at urography—for example, in congenital megaureter there is usually a narrow ureteric segment proximal to the bladder.¹⁴

A source of potential confusion in the diagnosis of obstruction is the absence of any relation between the degree of

dilatation of the pelvicaliceal system and the functional severity of obstruction. In acute obstruction of the ureter by a calculus the dilatation of the pelvicaliceal system and ureter is usually mild, even with complete obstruction. In some severe cases of chronic obstruction—for example, those caused by retroperitoneal fibrosis or malignancy—dilatation may also be mild.¹⁵

Diagnosis of dilatation of the collecting system by ultrasonography

Ultrasonography provides sectional images of the kidney that do not show the pelvicaliceal system in most normal people. At the centre of the kidney there is a cluster of bright echoes—the sinus echoes—largely produced by renal sinus fat. When the collecting system dilates a multiloculate fluid collection is seen in the sinus. This is made up of the larger renal pelvis, lying centrally, communicating with the smaller peripheral calices.

Although the collecting system is not seen in most normal people, it may be visualised if there is a high fluid intake with diuresis. Even slight ureteric hold up caused by a distended bladder may cause visualisation of a normal collecting system. Some anatomical variants such as a large major calix or an extrarenal pelvis may also cause visualisation.

Unlike urography, ultrasonography does not visualise the normal ureter. Even when the ureter is dilated much of its mid-part is usually hidden by gas in the bowel and only the upper and lower few centimetres are seen. Nor does ultrasonography provide the functional evidence of obstruction given by excretion of contrast medium during urography.

Sensitivity and specificity of ultrasonography in renal obstruction

Carefully performed ultrasonography is a very sensitive detector of collecting system dilatation in obstruction both when renal function is normal and when it is impaired.¹⁶⁻²² Even minor degrees of dilatation may be detected. To achieve high sensitivity the scanning technique must be painstaking and the images carefully interpreted. If mild dilatation in patients with acute obstruction and some with longstanding obstruction is not to be overlooked any degree of visualisation of the collecting system must be treated as important until it has been shown that it is not due to obstruction.²³

Misinterpretation may occur if fluid collections within the kidney apparently do not communicate and are considered to be cysts.²⁴ When obstruction is a clinical possibility, any central fluid collections in the kidney must be treated as potentially important. There is potential for false negative results on ultrasonography if the pelvicaliceal system is filled with solid material such as calculus, blood clot, or pus.²⁰⁻²⁴ Plain films should be used, supplemented if necessary by plain tomography, to detect opaque calculi, which may obscure a dilated pelvicaliceal system. False negative results may also occur if dehydration or underlying renal parenchymal disease cause a low urine output, which may be associated with a non-dilated obstructed system.²⁴

Even with careful technique and interpretation dilatation is not seen with ultrasonography in a few patients with obstructive renal failure.⁶⁻¹⁰ Most such patients show no dilatation on computed tomography or antegrade pyelography. The diagnosis is made only when there is improvement of renal function after percutaneous drainage. In patients with renal failure for which a cause cannot be found it may occasionally be necessary to consider either antegrade or retrograde pyelography to diagnose obstruction.

If, then, any visualisation of the collecting system with ultrasonography is considered potentially important the

investigation may be expected to be non-specific—and the incidence of false positive results has been reported as high as 26%.¹⁶⁻¹⁷⁻²⁰⁻²¹ In most non-obstructive causes of dilatation ultrasonography shows only a dilated collecting system in the kidney. By comparison urography is much more specific. The greater anatomical detail that urography provides enables the identification of anatomical variants, such as a large major calix or extrarenal pelvis, and non-obstructive pelvicaliceal pathology, such as blunted calices in reflux nephropathy or papillary necrosis; all these may cause pelvicaliceal visualisation with ultrasonography.²⁴ The ability of urography to show whether the ureter drains or whether there is ureteric hold up is also important in separating the non-obstructed distensible systems from those with obstruction. When ultrasonography shows multiple central fluid collections in the presence of parapelvic cysts, urography shows that the collecting system is compressed but that no contrast medium enters the fluid collections.

Mild dilatation of the collecting system is the most usual false positive observation with ultrasonography.¹⁶⁻²¹ A recent study showed that when this was an incidental finding the incidence of obstruction was low (less than 6%)—but when obstruction was clinically suspected about half the patients with mild dilatation were obstructed.²⁵ The use of duplex Doppler techniques may increase the specificity of ultrasonography. Some patients' false positive results are caused by visualisation of normal intrarenal vessels, particularly veins. Duplex Doppler shows a typical venous or arterial waveform arising from the central renal fluid collection in these patients.²⁶ Increases in the resistance of the intrarenal vessels detected by duplex Doppler may also differentiate obstructed from non-obstructed dilated systems.²⁷ The specificity and reproducibility of these findings need further evaluation.

Because of this poor specificity, visualisation of the collecting system with ultrasound usually requires further investigation by urography, computed tomography, or antegrade pyelography. The choice of technique depends on the degree of dilatation, the renal function, and how strongly obstruction is suspected.

The place of ultrasonography in suspected obstruction

Given this background understanding of the interpretation of visualisation of the collecting system on ultrasonography, a series of recommendations may be made about its use in suspected obstruction.

Suspected acute obstruction (for example, ureteric colic)—Urography remains the investigation of choice. It shows and locates calculi in the ureter and in many cases provides additional functional evidence of obstruction. Although ultrasonography can show the mild dilatation of acute obstruction, it cannot differentiate this from visualisation of the collecting system in the well hydrated normal person. In many patients the combination of ultrasonography and plain radiographs does not show the site and cause of obstruction.²⁸⁻²⁹ Ultrasonography and plain radiography may be used if there is a history of allergy to contrast medium or to follow up patients with a known opaque ureteric stone.

Suspected ureteric colic in pregnancy—Ultrasonography is often unhelpful because normal pregnant women show dilatation of the pelvicaliceal systems and ureters from as early as 12 weeks' gestation.³⁰ Pelvicaliceal dilatation shown by ultrasonography is therefore of no value in indicating whether there is ureteric obstruction. A limited intravenous urogram is the investigation of choice.

Loin pain with suspected chronic obstruction—As the likely diagnoses are obstruction of the ureter by calculus or

pelviureteric junction obstruction the technique of choice is urography, supplemented if necessary by frusemide.

Prostatism or pelvic neoplasm: rule out obstruction—In most patients ultrasonography is the technique of choice.³¹ If the surgeon wishes the ureter delineated preoperatively in a patient with a pelvic neoplasm urography is necessary.

Renal failure—Ultrasonography combined with plain radiography and plain renal tomography is a satisfactory first investigation.²⁰⁻²² The potential importance of minor dilatation of the collecting system cannot be over emphasised, and further investigation is essential in all patients in whom the collecting system is visualised.

Evaluation of transplanted kidneys—In transplanted kidneys the normal collecting system may be visualised because of minor degrees of hold up at the ureterovesical junction or because of vesicoureteric reflux. Baseline ultrasonography should be performed soon after transplantation. If renal function deteriorates follow up ultrasonography may be used to check for any increase in dilatation of the collecting system indicating possible obstruction.

Suspected obstruction in the presence of infection—Ultrasonography is the method of choice to detect dilatation of the collecting system in those few patients with urinary tract infection in whom an obstructed pyonephrosis is suspected because of severe loin pain and systemic upset.

Suspected obstruction in cystic disease—In patients with multiple renal cysts, including those with adult polycystic kidney disease, ultrasonography cannot diagnose dilatation of the collecting system because of the multiple intrarenal fluid collections. Urography is therefore indicated.

Suspected obstruction in patients with ileal loop diversion—Some reflux into the ureters with intermittent dilatation of the upper tracts is a normal finding. Ultrasonography is therefore not a good method of checking for possible upper tract obstruction, and urography or ileal loopography are better.³²

Conclusions

Ultrasonography is a highly sensitive but non-specific detector of dilatation of the collecting system. It is best used as a screening method when there is a clinical suspicion of chronic rather than acute obstruction. For safe and effective use the technique must be painstaking and the interpretation careful. The choice of further investigation when the collecting system is visualised by ultrasonography will be guided by the clinical findings and the renal function in each particular patient.

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- 1 Talner LB. Urinary obstruction. In: Grainger RG, Allison DJ, eds. *Diagnostic radiology*. Edinburgh: Churchill Livingstone, 1986:1067-87.
- 2 Ansell G, Tweedie MCK, West CR, Evans DAP, Couch L. The current status of reactions to intravenous contrast media. *Invest Radiol* 1980;15(suppl):31-9.
- 3 Shehadi WH, Toniolo G. Adverse reactions to contrast media: a report from the committee on safety of contrast media of the International Society of Radiology. *Radiology* 1980;137:299-302.
- 4 Hartman GW, Hattery RR, Witten DM, Williamson B. Mortality during excretory urography. *AJR* 1982;139:919-22.
- 5 Sanders RC, Bearman S. B-scan ultrasound in the diagnosis of hydronephrosis. *Radiology* 1973;108:375-82.
- 6 Rascoff JH, Golden RA, Spinowitz BS, Charytan C. Nondilated obstructive nephropathy. *Arch Intern Med* 1983;143:696-8.
- 7 Naidich JB, Rackson ME, Mossey RT, Stein HL. Nondilated obstructive uropathy: percutaneous nephrostomy performed to reverse renal failure. *Radiology* 1986;160:653-7.
- 8 Maillet PJ, Pelle-Francoz D, Laville M, Gay F, Pinet A. Nondilated obstructive acute renal failure: diagnostic procedures and therapeutic management. *Radiology* 1986;160:659-62.
- 9 Lyons K, Matthews P, Evans C. Obstructive uropathy without dilatation: a potential diagnostic pitfall. *Br Med J* 1988;296:1517-8.
- 10 Spital A, Valvo JR, Segal AJ. Non-dilated obstructive uropathy. *Urology* 1988;31:478-82.
- 11 Davies P. Obstructive uropathy. *Br Med J* 1988;297:68.
- 12 Spiro FI, Fry IK. Ureteric dilation in non-pregnant women. *Proceedings of the Royal Society of Medicine* 1970;63:462-4.
- 13 Whitfield HN, Britton KE, Hendry WF, Wickham JEA. Frusemide intravenous urography in the diagnosis of pelviureteric junction obstruction. *Br J Urol* 1979;51:445-8.
- 14 Hamilton S, Fitzpatrick JM. Primary non-obstructive megaureter in adults. *Clin Radiol* 1987;38:181-5.
- 15 Lalli AF. Retroperitoneal fibrosis and inapparent obstructive uropathy. *Radiology* 1977;122:339-42.
- 16 Ellenbogen PH, Scheible FW, Talner LB, Leopold GR. Sensitivity of greyscale ultrasound in detecting urinary tract obstruction. *AJR* 1978;130:731-3.
- 17 Malave SR, Neiman HL, Spies SM, Cisternino SJ, Adamo G. Diagnosis of hydronephrosis: comparison of radionuclide scanning and sonography. *AJR* 1980;135:1179-85.
- 18 Lee JKT, Baron RL, Melson GL, McLennan BL, Weyman PJ. Can real-time ultrasonography replace static B-scanning in the diagnosis of renal obstruction? *Radiology* 1981;139:161-5.
- 19 Dalla-Palma L, Bazzocchi M, Pozzi-Mucelli RS, Stacul F, Rossi M, Agostini R. Ultrasonography in the diagnosis of hydronephrosis in patients with normal renal function. *Urol Radiol* 1983;5:221-6.
- 20 Talner LB, Scheible W, Ellenbogen PH, Beck CH, Gosink BB. How accurate is ultrasonography in detecting hydronephrosis in azotaemic patients? *Urol Radiol* 1981;3:1-6.
- 21 Webb JAW, Reznick RH, White FE, Cattell WR, Fry IK, Baker LRI. Can ultrasound and computed tomography replace high dose urography in patients with impaired renal function? *Q J Med* 1984;211:411-25.
- 22 Denton T, Cochlin DL, Evans C. The value of ultrasound in previously undiagnosed renal failure. *Br J Radiol* 1984;57:673-5.
- 23 Curry NS, Gobien RP, Schabel SI. Minimal-dilatation obstructive nephropathy. *Radiology* 1982;143:531-4.
- 24 Amis ES, Cronan JJ, Pfister RC, Yoder IC. Ultrasonic inaccuracies in diagnosing renal obstruction. *Urology* 1982;19:101-5.
- 25 Kamholtz RG, Cronan JJ, Dorfan GS. Obstruction and the minimally dilated renal collecting system: US evaluation. *Radiology* 1989;170:51-3.
- 26 Scola FH, Cronan JJ, Schepps B. Grade I hydronephrosis: pulsed Doppler US evaluation. *Radiology* 1989;171:519-20.
- 27 Platt JF, Rubin JM, Ellis JH. Distinction between obstructive and nonobstructive pyelocaliectasis with duplex Doppler sonography. *AJR* 1989;153:997-1000.
- 28 Laing FC, Jeffrey RB, Wing VW. Ultrasound versus excretory urography in evaluating acute flank pain. *Radiology* 1985;154:613-6.
- 29 Hill MC, Rich RI, Mardiat JG, Finder CA. Sonography versus excretory urography in acute flank pain. *AJR* 1985;144:1235-8.
- 30 Cietak KA, Newton JR. Serial qualitative maternal nephrosonography in pregnancy. *Br J Radiol* 1985;58:399-404.
- 31 Fidas A, Mackinlay JY, Wild SR, Chisholm GD. Ultrasound as an alternative to intravenous urography in prostatism. *Clin Radiol* 1987;38:479-82.
- 32 Cronan JJ, Amis ES, Scola FH, Schepps B. Renal obstruction in patients with ileal loops: US evaluation. *Radiology* 1986;158:647-8.